IMPACT OF NATURAL ZEOLITE ON GROWTH PERFORMANCE, FEED EFFICIENCY, AND CARCASS COMPOSITION OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*, L.) CULTURED AT DIFFERENT STOCKING DENSITIES

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Received 5 /7 /2020 *Accepted 23 /8 /2020*

ABSTRACT

The present experiment was carried out to evaluate the effects of supplementation of the graded levels of zeolite (0, 50, and 100 g/kg diet) on Nile tilapia (*Oreochromis niloticus*) reared at two stocking densities (SD) (100 and 200 fish/m^3), regarding its growth performance, feed utilization, and fish carcass composition. Fish (9.56 ± 1.77 g) were distributed into sex treatments in triplicates and fed the experimental diets at 3% of live body weight for 15 weeks. The obtained results revealed that fish reared at high SD (200 fish/m^3) had adverse significant effects on growth performance, feed utilization, and fish carcass composition parameters compared to those reared at low SD (100 fish/m^3). However, the addition of dietary zeolite at a level of 50 g/kg diet significantly improved these adverse effects of high SD. Hence, the significant interaction between high SD and levels of dietary zeolite was detected in most of the above-mentioned parameters. Therefore, it could be concluded that zeolite supplementation at a level of 50 g/kg diet is useful to minimize the adverse effects of high density for enhancing the production performance of Nile tilapia, *O. niloticus*.

Keywords: Nile tilapia - zeolite - stocking density - growth performance – feed utilization – carcass composition.

INTRODUCTION

The human demand for fish consumption increased all over the world due to the continuous increase in the human population. Fish is about to become the main alternative source of animal protein. Aquaculture continues to play an important role in food production in the world by providing high-quality protein to people every year (Leung *et al*., 2013). The global aquaculture sector contributed 42.2% of the world food fish production in 2016 and accounted for half of the world's fish for direct consumption (FAO, 2018). Stocking density is considered one of the most important variables in intensive aquaculture influencing the growth, welfare, and health of farmed fish (Ellis *et al*., 2002; Ni *et al*., 2014). In commercial aquaculture, operation at higher stocking densities can reduce production costs, but high stocking density is a stressor, which induces chronic stress associated with deterioration in water quality, adverse social interactions, or over-crowding, resulting in negative physiological and biochemical changes (Montero *et al*., 1999 and Bolasina *et al*., 2006).

Dietary additives are widely used in aquaculture to promote growth performance and minimize the stress effects on fish growth and welfare. Natural zeolites are a family of minerals of volcanic origin that are made of crystalline aluminosilicates with excellent ion exchanging properties (Eya *et al*., 2008). Zeolites are crystalline, hydrated aluminosilicates of alkali (e.g. Na^{+}, K^{+}), and alkaline (e.g. Mg^{+2}, Ca^{+2}) earth cations, consisting of three-dimensional frameworks of SiO^{-4} and AlO^{-5} tetrahedral linked through the shared oxygen atoms (Papaioannou *et al*., 2005). Zeolites are used in industry, agriculture, environment protection, and even in medicine. Zeolite as a feed additive has shown numerous positive results in growth performance, conversion nutrition improvement, mortality reduction, and toxin elimination in different animals (Obradovic *et al*., 2006). In fish species, different types of zeolites mainly clinoptilolite caused an enhancement in water quality, fish health, and growth performance (Peyghan and Azary, 2002; Obradovic *et al*., 2006 and Eya *et al*., 2008). Zeolite could also improve the growth indices, nutrient absorption blood profile, and decrease pathogenic bacteria in aquatic animals (Eya *et al*., 2008; Hu *et al.*, 2008; Yildirım *et al*., 2009 and Jawahar *et al*., 2016). Clinoptilolites were shown to be highly effective for the metabolic utilization of nitrogen in animals and poultry. This may indicate that one may decrease the concentration of nitrogen-containing substances in rations without affecting animal performance (Strakova *et al*., 2008). Zeolite ion exchange might be a useful alternative to biofiltration for NH^{4+} removal and have the advantages of low cost and high tolerance temperatures fluctuations and chemical conditions (Johnson and Harikrishnan, 2003). Zeolite has been recommended and used effectively in reducing the toxic effects of materials such as aflatoxins (Jand *et al.*, 2005 and Hassaan *et al*., 2020). There is evidence that zeolite can be used as an antimicrobial agent (Haile and Nakhla, 2010). Therefore, the present experiment aimed to study the impact of different levels of dietary zeolite on growth, feed efficiency, and carcass composition of Nile tilapia under different stocking densities

MATERIALS AND METHODS

Experimental facilities:

The components of tested diets were bought from a local market. The ingredients were minced and natural zeolite was added at levels of 0, 50, and 100 g/kg diet (Table 1). The diet's ingredients were thoroughly mixed with 100 mL of water per one kg of diet to make a dough. Afterward, the dough was then passed through a meat grinder and the resultant strings were left to be dried for 24 hours; then crushed to be the 1-mm diameter pellets. The experimental diets were kept at 4°C for further use.

The present experiment was carried out in the wet Laboratory of Department of Fish Nutrition, Central Laboratory of Aquaculture Research (CLAR), Abbassa, Abou-Hammad, Sharkia Government, Egypt. Five hundred and forty Nile tilapia *O. niloticus*, fingerlings with average initial body weight 9.56 ± 1.77 g were obtained from a fish hatchery of CLAR, Abbassa, Abou-Hammad. Fingerlings were adapted for two weeks at the experimental conditions during which fish were fed a basal diet containing 30 % crude protein. Fish were randomly distributed into eighteen 200-L glass aquaria at densities of 100 or 200 fish/m^3. Under each density, fish were fed on diets containing 0, 50, or 100 g zeolite/kg diet (three replicates/treatment). Each aquarium was supplied with compressed air via air-stones using aquarium air pumps. Fish of each aquarium were fed at 3 % of live fish biomass and the experimental diets were introduced two times by equal amounts at 9 am and 2 pm by hand. Settled fish wastes with one half of the aquarium's water were removed daily by siphoning and water volumes were replaced by dechlorinated aerated tap water from a storage tank. The water temperature range was 26 – 28 °C. Fish in each aquarium were weighed biweekly and the amounts of the required feed were readjusted accordingly. The proximate chemical analysis of diets was conducted according to AOAC (2004), as shown in Table (2).

Table 1. Details of the experimental treatments.

Treatment	Details
T_1	100 fish/m + 0 g natural zeolite / kg diet (as a control)
T_2	100 fish/m + 50 g natural zeolite / kg diet
T_3	100 fish/m + 100 g natural zeolite / kg diet
T_4	200 fish/m + 0 g natural zeolite / kg diet (as a control)
T_5	200 fish/m + 50 g natural zeolite / kg diet
T_6	200 fish/m + 100 g natural zeolite / kg diet

Table 2. Ingredients and chemical analysis (%; on a dry matter basis) of the experimental diet**.**

Ingredients	Gram per 1000 g diet
Fish meal	100
Soybean meal	440
Wheat milling by product	150
Yellow corn	210
Corn starch	20
Oil mixture [1]	50
Vitamin premix [2]	10
Mineral premix [3]	20
Total	1000
Nutrient composition (% on dry matter basis)	
Dry matter (DM, %)	92.55
Crude protein (CP, %)	30.00
Ether extract (EE, %)	5.99
Crude fiber (CF, %)	2.15
Ash (%)	4.95
Total carbohydrate (%)	56.40
Gross energy [4] (Kcal / 100 g)	476.03
Protein to energy ratio P /E ratio mg CP / Kcal	66.08

[1] Sunflower oil: cod liver oil at a ratio of 1:1.

[2-3] Minerals and vitamins premix each one kg contain Vit. A,15000 IU; Vit. D_3, 15000 IU; Vit. E, 2 mg; Vit. K_3, 2 mg; Vit. B_1, 2 mg; Vit. B_2, 2.5 mg; Nicotine amide, 10 mg; Vit. B_6, 3 mg; Vit. B_{12}, 5 mg; Folic acid, 2 mg; Ca – d –Pantothenate, 5.5 mg; Calcium, 200 g; Phosphate, 90 g; Sodium, 40 g; Cupper, 2.5 g; Magnesium, 48 g; Manganese, 3.6 g; Zinc, 23.5 g; Iron, 8 g; Cobalt, 450 mg; Iodine, 200 mg; Selenium, 20 mg.

[4] Calculated by using factors of 5.65, 9.44, and 4.11 Kcal per gram of protein, fat, and total carbohydrates, respectively (NRC, 1993).

Fish performance parameters:

After the end of the experiment, fish of each aquarium were collected, counted, and weighed. The parameters of growth and feed utilization were calculated as follows:

Weight gain (WG; g) = $W_f - W_i$

Daily gain (DG; g) = $(W_f - W_i) / t$

Relative growth rate (RGR) = $(W_f - W_i) / Wi$

Specific growth rate (SGR; %/day) = $100\ (\ln W_f - \ln W_i)/t$

Fish survival (%) = 100 (fish number at the final / fish number at the start).

Where, W_i and W_f are initial and final weights (g), respectively, and t is the time of the experiment (days).

Feed conversion ratio (FCR)= dry feed intake (g)/ fish live weight gain (g);

Feed efficiency ratio (FER)= fish live weight gain (g)/ dry feed intake (g).

Protein efficiency ratio (PER)= body weight gain (g)/ protein intake (g).

Carcass composition:

At the end of the experiment, fish samples were collected and kept frozen (– 20°C) until the proximate analysis of the whole body was done according to AOAC (2004). Their energy content was calculated according to NRC (1993).

Statistical analysis:

The obtained data were statistically analyzed using SAS (2009) for users guide, with factorial design (2 × 3) using two-way ANOVA to test the effects of zeolite levels and stocking density. All ratios and percentages were arcsine-transformed before statistical analyses. The differences between the mean of treatments were compared using Tukey's post hoc significant test, and differences were considered statistically significant at $P \leq 0.05$.

RESULTS

Growth performance parameters:

Data in Table 3 showed growth performance of Nile tilapia, *O. niloticus* reared under stocking densities of 100 and 200 fish/ m^3, and fed different levels of 0, 50 and 100 g zeolite/kg diet. Results showed that FW, TWG, ADG, RGR, and SGR significantly decreased by increasing the fish stocking density ($P \leq 0.05$). On another hand, the addition of dietary zeolite at a level of 50 g /kg diet resulted in significant increases in all growth parameters and fish survival, followed by the control group, then 100 g zeolite/kg diet. Results displayed that fish fed 50 g zeolite/kg diet had the highest growth performance parameters in both SD (100 and 200 fish/m^3) ($P \leq 0.05$; Table 3).

Table 3. Growth parameters of Nile tilapia at different stocking density and fed different dietary zeolite levels for 15 weeks.

Stocking Density (fish/m^3)	Zeolite levels (g/kg diet)	IW (g)	FW (g)	WG (g)	DG (g/fish/day)	RGR (%)	SGR (%/day)	Fish survival (%)
100	0	9.60 ±0.00	23.47^b ±0.09	13.87^b ±0.09	0.152^b ±0.00	144.5^b ±0.72	0.992^b ±0.00	92.50 ±1.44
	50	9.63 ±0.03	25.20^a ±0.40	15.53^a ±0.38	0.173^a ±0.00	161.5^a ±3.88	1.072^a ±0.02	96.67 ±1.67
	100	9.60 ±0.00	21.50^c ±0.46	11.90^c ±0.46	0.134^c ±0.01	123.9^c ±4.94	0.904^c ±0.02	93.33 ±3.33
200	0	9.50 ±0.00	20.77^b ±1.07	11.27^b ±1.07	0.134^b ±0.01	118.4^b ±11.40	0.874^b ±0.06	92.50^a ±1.44
	50	9.53 ±0.03	21.87^a ±0.49	12.30^a ±0.46	0.142^a ±0.01	129.0^a ±5.08	0.920^a ±0.02	95.83^a ±1.67
	100	9.53 ±0.03	17.27^c ±0.03	7.77^c ±0.03	0.090^c ±0.00	81.27^c ±0.17	0.666^c ±0.00	79.17^b ±7.41
Two-way ANOVA (P-value)								
Stocking density (SD)		0.256	0 .0001	0.0001	0.0001	0.0001	0.0001	0.023
Zeolite levels (Z)		0.396	0.0001	0.0001	0.0001	0.0001	0.0001	0.001
SD x Z		0.723	0.394	0.384	0.416	0.374	0.184	0.045

Mean in the same column having different small letters are significantly different ($P \leq 0.05$). IW: initial weight; FW: final weight (g); TWG: total weight gain (g); ADG: average daily gain (g/fish/day); RGR: relative growth rate (%); SGR: Specific growth rate (%/day).

Feed utilization:

Feed efficiency parameters of Nile tilapia, *O. niloticus* reared under different SD rates (100 and 200 fish/m^3) and fed different levels of dietary zeolite (0, 50, and 100 g / kg diet) were illustrated in Table 4. With increasing stocking density, FI, FE, and PER were significantly decreased, while FCR was increased. The addition of dietary zeolite to Nile tilapia diets led to improve feed efficiency parameters, where fish fed a diet containing 50 g dietary zeolite /kg diet gave the best values compared to other levels (0 and 100 g dietary zeolite/kg diet). Fish stocked at 100 fish/m^3 and fed 0 g dietary zeolite /kg diet gave the highest values of FI compared to other zeolite levels (0 and 100 g dietary zeolite/kg diet) (Table 4). While fish fed 50 dietary zeolite /kg diet in the case of fish reared in high SD (200 fish/m^3) gave significantly the highest value of FI. The same trend was observed in other parameters such as FCR, FE, and PER in both fish densities.

Table 4. Feed efficiency parameters of Nile tilapia at different stocking density and fed different Zeolite levels for 15 weeks.

Stocking Density (fish/m^3)	Zeolite levels (g/kg diet)	FI (g)	FCR	FER (%)	PER (%)
100	0	28.57^{a} ±0.38	2.06^{b} ±0.01	48.64^{b} ±0.33	1.62^{b} ±0.01
	50	27.30^{ab} ±0.51	1.76^{c} ±0.07	57.09^{a} ±2.39	1.90^{a} ±0.08
	100	26.73^{b} ±0.96	2.25^{a} ±0.08	44.56^{c} ±1.53	1.49^{c} ±0.05
200	0	25.13^{b} ±0.38	2.26^{b} ±0.19	44.76^{b} ±3.62	1.49^{b} ±0.12
	50	26.13^{a} ±0.66	2.12^{c} ±0.06	47.12^{a} ±1.41	1.57^{a} ±0.05
	100	21.93^{c} ±0.29	2.83^{a} ±0.04	35.36^{c} ±0.54	1.18^{c} ±0.02
Two-way ANOVA (P-value)					
Stocking density (SD)		0.0001	0.0003	0.0005	0.0005
Zeolite levels (Z)		0.001	0.0001	0.0002	0.0002
SD x Z		0.024	0.0166	0.282	0.274

Mean in the same column having different small letters are significantly different ($P \leq 0.05$). FI: feed intake; FCR: feed conversion ratio; FE: feed efficiency; PER: protein efficiency ratio.

Fish carcass composition:

The effect of stocking density and different levels of dietary zeolite on the fish carcass composition of Nile tilapia, *O. niloticus* at the end of the experiment was summarized in Table 5. Fish cultivated in SD at 200 fish/m^3 had significantly ($P \leq 0.05$) increased lipids content compared to the low SD (100 fish/m^3). However, no significant differences were found in moisture, ash, protein, and energy contents between different stocking densities ($P \geq 0.05$), while fish fed dietary zeolite at level 50 g/kg diet showed a significant increase in energy compared to other treatments. However, no significant differences in moisture, lipids, ash, and protein among all dietary zeolite levels ($P \geq 0.05$).

Fish stocked at 100 fish/m^3 and fed on 0 g zeolite /kg diet gave the highest values of lipids and ash contents compared to other zeolite levels (0 and 100 g dietary zeolite/kg diet), while fish fed 50 g zeolite /kg diet in the case of fish reared at low SD (100 fish/m^3) gave significantly the highest value of FI. Lipids and energy contents have recorded the highest values in fish stocked 200 fish/m^3 and fed on 100 g zeolite/kg diet, while fish stocked at a density of 200 fish/m^3 and fed on 50 g zeolite/kg diet gave highest values of moisture and ash contents among other levels of dietary zeolite. However, no significant differences in protein content among levels of dietary zeolite in different stocking densities ($P \geq 0.05$).

Table 5. Carcass composition (% on a dry weight basis) of Nile tilapia at different stocking density and fed different zeolite levels for 15 weeks.

Stocking Density (fish/m^3)	Zeolite levels (g/kg diet)	Moisture (%)	Total fat (%)	Crude protein (%)	Ash (%)	EC (Kcal/100 g)
100	0	75.30[a] ±0.00	16.20[a] ±0.12	67.60[a] ±0.47	16.20[b] ±0.40	534.2[a] ±2.10
	50	74.45[b] ±0.20	15.77[b] ±0.08	67.52[a] ±0.41	16.72[ab] ±0.34	529.6[a] ±1.61
	100	74.30[b] ±0.15	14.55[c] ±0.11	67.92[a] ±0.16	17.53[a] ±0.06	520.4[b] ±0.32
200	0	74.40[a] ±0.40	16.71[a] ±0.09	67.08[ab] ±0.41	16.21[b] ±0.40	536.1[a] ±2.25
	50	74.45[a] ±0.14	15.50[b] ±0.27	67.44[a] ±0.51	17.05[b] ±0.39	526.8[b] ±2.22
	100	74.15[a] ±0.20	15.63[b] ±0.34	65.60[b] ±0.46	18.77[a] ±0.16	517.5[c] ±0.92
Two-way ANOVA (P-value)						
Stocking density (SD)		0.074	0.015	0.015	0.066	0.378
Zeolite levels (Z)		0.042	0.0001	0.231	0.0002	0.0001
SD x Z		0.131	0.014	0.046	0.0181	0.0316

Mean in the same column having different small letters are significantly different ($P \leq 0.05$); EC: energy content.

DISCUSSION

Stocking density is considered as one of the vital factors determining fish production and profitability in aquaculture practices. High stocking density may cause chronic stress and reduce fish welfare (North *et al*., 2006 and Lupatsch *et al*., 2010). The depressing effects of high SD on fish growth performance recorded in many studies on several fish species including Nile tilapia, *O. niloticus* (Khattab *et al*., 2004; Bakeer *et al*., 2007 and Mehrim *et al*., 2017), African catfish (El-Haroun, 2007), and channel catfish, *Ictalurus punctatus* (Refaey *et al*., 2018). On the other hand, some fish species like tilapias can tolerate extreme crowding although competition for food will then limit their growth and lead to poor weight gain. The negative effect of high SD in the present study could be a result of triggered an increasing request for energy to activate the physiological responses to cope with stress and led to a reduction in the available energy for growth (Wendelaar, 1997 and Qi *et al*., 2016). Moreover, social interactions through competition for food and/or space can negatively affect fish growth (Yi *et al*., 1996 and Huang and Chiu, 1997). Furthermore, increasing stocking density caused deterioration in water quality parameters, resulting in stressful conditions on fish (Mehrim, 2009 and M'balaka *et al*., 2012). In addition, Li *et al*. (2012) and Refaey *et al.* (2018) indicated that high SD caused the decline of the amount of thyroid hormones available for target tissues of fish, causing growth suppression of sturgeon and channel catfish.

Results obtained from the present study displayed the positive effect of dietary zeolite on growth performance, especially a level of 50 g kg/diet, which exhibited the highest growth performance irrespective of fish density. This effect may be related to zeolite increased digestibility coefficients of dry matter and protein leading to improve growth (Khodanazary *et al*., 2013). Moreover, Steica and Morea (2013) concluded that the binding effect of zeolite improved feed and reduced wastage, increased feed palatability, and working to put food to the effect of enzymes for a longer period and thus being a growth promotor.

The optimistic effects of dietary zeolite on fish growth performance recorded in many studies on several fish species including Nile tilapia, *O. niloticus* (El-Gendy *et al.*, 2015); *Tilapia zilli* (Yıldırım *et al.*, 2009); common carp, *Cyprinus carpio* (Mostafa *et al.*, 2010 and Khodanazary *et al.*, 2013), and *Oncorhynchus mykiss* (Walbaum) (Obradovic *et al.*, 2006 and Güler and Uçar, 2018). In contrast, the absence of any significant effect of dietary zeolite on growth performance has also been reported for red tilapia by Rafiee and Saad (2005) and *Astacus leptodactylus* by Zamani *et al*. (2007). The reasons for the differences among previous studies on the growth-enhancing effect by dietary zeolite may be related to the species of fish, source, properties, and incorporation levels of zeolite among others.

High stocking density in the present study led to a reduction in feed efficiency parameters. Additionally, the results exhibited a negative reduction in feed consumption, which probably attributes to reducing the fish appetite. The reduction of fish appetite increased the stress via the competition for food and/or living space (Duan *et al*., 2011). Likewise, Abdel-Tawwab *et al*. (2014) and Refaey *et al*. (2018) found that the appetite of Nile tilapia, *O. niloticus*, and channel catfish, *I. punctatus* was diminished at higher fish density. Boujard *et al*. (2002) suggested that fish adapted to crowding stress by reducing the feed intake. Additionally, crowding stress causes several changes in energy metabolism leading to deviate the energy to face the stress-producing a drop in feed conversion efficiency (Lupatsch *et al*., 2010). Li *et al*. (2012) found an increase in FCR and a decrease in feed efficiency at higher stocking density.

Results in the current study showed that the adding of zeolite at level 50 g/kg diet led to improved feed efficiency parameters, which gave the best values of FCR, FE, and PER. This improvement may be related to better nutrient utilization, which can be explained by a slower passage of pre-digested food through the intestine, leading to improved nutrients absorption, particularly nitrogen (Mumpton and Fishman, 1977 and Dias *et al.*, 1998). Moreover, Steica and Morea (2013) concluded that the binding effect of zeolite improved feed quality reduced wastage, and increased its palatability. Zeolite also is working to put diets to the effect of enzymes for a longer period and thus enhanced feed utilization. Also, Khodanazary *et al*. (2013) and Yildirim *et al*. (2009) indicated that fish fed on diets supplemented with 1 and 2 % zeolite had a higher PER and FCR than that fed diet without zeolite. Khodanazary *et al*. (2013) reported that supplementing zeolite and perlite increased digestibility coefficients of dry matter and protein compared with the control. Yıldırım *et al*. (2009) reported that zeolite used as a feed additive improves feed evaluation ratios of tilapia fish. Ghiasai and Jasour (2012) found that FCR and SGR were significantly increased as a result of zeolite application for angelfish (*Pterophyllum scalare*) diet.

The chemical composition of the whole-fish body is one of the main measurements to judge the quality of fish meat. The high SD led to an increase in the lipids content and a decrease in the protein content in the whole-fish body. In contrast, Refaey *et al*. (2018) found the reduction of lipids content at high SD in the channel catfish. The stress caused by high SD could affect metabolic enzymes related to lipids metabolism (Montero *et al*., 1999 and Menezes *et al*., 2015). On the other hand, low-lipids content in fish reared at high SD can be attributed to the low feed intake. On the other hand, changes in protein and lipids contents in the whole-fish body could be linked with changes in their synthesis, deposition rate in muscle, and/or different growth rates (Abdel-Tawwab *et al*., 2006).

The obtained results in the present study revealed that the increase of dietary zeolite levels led to significant increments in DM and ash contents and decreased lipids, protein, and energy contents irrespective of fish density. The increased ash content accompanied with increasing zeolite levels may be due to that zeolites have a relatively high Si/Al compositional ratio, which gives them the special ion-exchange reactions for large cations and ease adsorb metals ions leading to the increment in ash content in the whole-fish body (Zorpas *et al*., 2000). While, the decrease of lipids, protein, and energy contents in the whole-fish body may be due to increased metabolism rate to meet the growing demand for energy under high SD (200 fish/m^3). However, zeolite is shown to be highly effective regarding the metabolic utilization of nitrogen in the fish body because of its ability to absorb the positive ions such as nitrogen in artificial diets and water (Ibrahim *et al*., 2016), and indicated that the increase of dietary zeolite levels in Nile tilapia diets led to increments in protein contents and decreases in DM, ash, and lipids contents. In a contrary study, Hsu and Chung (2001) observed an increase in lipids, and ash contents when adding up to 2% zeolite or more.

CONCLUSIONS

The obtained results revealed the adverse effects of high SD (200 fish/m^3) stress on the growth parameters of Nile tilapia, *O. niloticus* compared to the fish reared at low SD (100 fish/m^3). Also, the potential positive effects of zeolite at a level of 50 g/kg diet against the adverse effects of high density. Consequently, it could be concluded that the use of dietary zeolite at a level of 50 g/kg diet may be useful, regarding the predicted fish production.

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تأثير الزيوليت الطبيعي على أداء النمو وكفاءة التغذية وتركيب الذبائح في أسماك البلطي النيلي المستزرعة فى كثافات تخزينية مختلفة

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الملخـــــص العربـــــى

أجريت هذه التجربة لتقييم تأثيرات إضافة معدلات متدرجة من الزيوليت (٠، ٥٠، ١٠٠ جم / كجم علف) على أسماك البلطى النيلى التي يتم تربيتها في كثافات مختلفة (١٠٠ و٢٠٠ سمكة / م[3]) فيما يتعلق بأداء نموها، واستخدام العلف، وتركيب ذبيحة الأسماك. وزعت الأسماك بمتوسط وزن الجسم الأولي (٩.٥٦ ± ١.٧٧ جم) على ستة معاملات (ثلاثة مكررات لكل معاملة) وتغذت على العلائق المختبرة بمعدل ٣% من الوزن الحي لمدة ١٥ أسبوعًا. أوضحت النتائج المتحصل عليها أن الأسماك التي تمت تربيتها في كثافة تخزينية ٢٠٠ سمكة / م[3] لها تأثيرات سلبية معنوية على أداء النمو، واستخدام العلف، وتركيب ذبائح الأسماك مقارنة بالأسماك التي تم تربيتها في كثافة تخزينية ١٠٠ سمكة / م[3]. ومع ذلك فإن إضافة الزيوليت الغذائي بمعدل ٥٠ جم / كجم عليقة أدى إلى تحسن كبير في الآثار الضارة الناتجة عن ارتفاع كثافة التخزين على الأسماك مقارنة بمعدلات الزيوليت الأخرى. وبالتالي، تم الكشف عن وجود تفاعل معنوي بين كثافة التخزين ومستويات الزيوليت فى العلف في معظم القياسات المذكورة أعلاه. لذلك، يمكن الاستنتاج أن إضافة الزيوليت بمعدل ٥٠ جم / كجم عليقة لتحسين أداء الإنتاج من أسماك البلطى النيلى وخصوصا مع كثافات التخزين العالية.